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An Objective Means of Species Status Assessment: Adapting the Delphi Technique

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Abstract

A status assessment for wildlife species is necessary for many states in the United States with the authority to list species as endangered and threatened. Status may confer legal protection or conservation priority within a state. The methods used to define species status vary across states, but most rely on subjective determinations made by a group of experts. We adapted the Delphi Technique, a systematic method of reaching consensus, to achieve greater objectivity in determining the relative endangerment or stability of a species' population. We used the method to determine the status of birds native to New Jersey by having experts choose a status, enumerate their confidence in it and justify their choice, on forms via mail. We compiled results and sent them back to all participants to review the information anonymously provided by others and vote again on each status based on this information, as well as their own experience and opinion. We continued this process for 4 rounds, reaching consensus on the status of 91% of 283 species in breeding and nonbreeding seasons. We used the results to assign legal status of bird species in the state. We present this as an appropriate technique to attain greater objectivity in species status assessment. (WILDLIFE SOCIETY BULLETIN 34(2):419–425; 2006)

Key words

consensus, Delphi Technique, endangered, Endangered Species List, species status.

The United States Fish and Wildlife Service (USFWS) and many state wildlife agencies periodically assess the status of wildlife populations to determine whether a species should be listed as sensitive, threatened, or endangered. Species status is important because it confers additional legal protection and establishes conservation priorities for agencies. The USFWS species assessment process relies heavily on information provided by state and regional sources (U.S. Fish and Wildlife Service 2001). These assessments are conducted by agency biologists in concert with public input (Nicholopoulos 1999). State wildlife agencies that have the legal authority to conduct species status assessments typically use population levels and species vulnerability to make their decisions (Millsap et al. 1990). Because the status of a species has legal standing and may have economic implications, the process used should be rigorous and defensible.

As of 2004, 44 states reported having a formal sensitive species list (Niles and Korth 2005). Most states had procedures for maintaining the credibility of their lists, particularly through a formal list review process ranging from every year to every 10 years. However, a standard methodology for assessing a species status is lacking (Dobkin 1994). Niles and Korth (2005) reported that 30 states reviewed their lists frequently (every 5 years or less), and 13 reviewed their list as needed. The basis for establishing species status varied substantially, however, with only 19 states reporting use of explicit criteria for determining status (Niles and Korth 2005).

In a survey we conducted in 2002 on listing procedures, most states (57% of 42 states responding to this question; 49 total responding) reported using a process of review by experts in a group setting, where species status is determined by the group in a single evaluation meeting (R. Baum, Princeton University, Princeton, N.J., USA, unpublished data). Seven states reported using forms to gather experts' opinions, which were later tabulated by staff. New York was unique in reporting a method that involved a second review after initial status determinations. Only New Jersey reported using an iterative, anonymous method to reach consensus.

The expert review process used by most states has limitations. Consensus can be difficult to reach if information or personalities cause dissension in the group and not all experts are present. Some states have implemented a scoring method to quantify the facets of a species' life history, abundance, and distribution as a means to assess its vulnerability to extirpation (Landry et al. 1979, Millsap et al. 1990). Both methods usually are not iterative, thus may not always reflect an objective consensus of the participants (Dalkey 1969).

To determine status and conservation priority in Florida, the state's Game and Fresh Water Fish Commission adapted a method that ranks species status according to biological vulnerability and management needs (Millsap et al. 1990). The method incorporates biological and action scores. Biological scores are determined by summing 7 variables indicating distribution, abundance, and life history. Action scores are the sum of 4 variables reflecting the current distribution, population trends, limiting factors, and current conservation efforts. Scores are then ranked to determine the species' status. A similar technique that includes input from wildlife professionals and public stakeholders is used by Texas Parks and Wildlife Department (Thompson 1984). These 2 methods are similar in that each used a single-step evaluation process and had reviewers assign numbers to biological status, habitat condition, and threats to rank their evaluations. While the use of numbers appears to provide an objective methodology, assigning numbers to many of these factors is fraught with the same degree of subjectivity as expert opinion

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meetings. Further, these single-step processes do not offer the opportunity for consensus-building that comes through a multistage, iterative process.

The Delphi Technique

The Delphi Technique is a systematic method for reaching consensus among experts in which absolute, quantitative answers are either unknown or unknowable (Linstone and Turoff 1975). It is an iterative process characterized by anonymity among the participating experts, controlled feedback via the principal investigator, and a statistical estimator of group opinion (Dalkey 1969). By structuring the group communication process, the Delphi Technique helps the group reach a consensus of opinion by incorporating all available data and disseminating those data among all participants. This technique has been used to reach consensus decisions in natural resource management (Zuboy 1981, Applegate 1982, Nichols and Applegate 1987), wildlife habitat criteria for habitat suitability indices (Crance 1987, Jirka and Homa 1990, Uhmann et al. 2001), and for establishing water requirements for fish (Taylor and Ryder 2003). The technique also was used by Hess and King (2002) to choose focal wildlife species and important habitats for use in conservation planning in a suburban region of North Carolina.

We used the Delphi Technique to determine the status of 283 nongame bird species in New Jersey during breeding and nonbreeding seasons. We solicited the participation of recognized experts, but they were not identified by name during the process or at its completion. Rather, they participated in group decisions anonymously through the mail and reacted to common information. All communications flowed between the principal investigator and participants. We describe the methodology as applied to species status assessments and make recommendations for its use by state agencies. We present the full results of the assessment of bird species status.

Methods

The assessment of the status of New Jersey birds occurred in 2 parts. The initial evaluation in 1992–1994 included all 283 species known to occur in the state, and each species was assessed separately for the breeding and nonbreeding seasons (Dobkin 1994). The second assessment was limited to a subset of 13 species in 1997–1998 for which new information had become available since completion of the first assessment. The new information obtained from the completed New Jersey Breeding Bird Atlas and targeted surveys suggested declines or increases since the first assessment. A group of 6 biologists familiar with the more recent data chose the subset of species from the entire list of 283 species.

We contracted an expert from outside the agency to serve as principal investigator to develop and conduct the initial assessment of all 283 bird species. The principal investigator also was a member of the Endangered and Nongame Species Advisory Committee, an independent advisory group to the New Jersey Endangered and Nongame Species Program.

We selected participants based on their knowledge and experience with birds of New Jersey and their familiarity with the status of bird populations either regionally within the state or statewide. We identified 27 potential panelists for the initial assessment. We sent prospective panelists letters inviting them to participate; 21 agreed.

We mailed to all panelists detailed instructions, the evaluation sheets with a list of species (Fig. 1), and a postage-paid return envelope. We instructed participants to identify their evaluations with their initials for internal tracking only. We asked participants to choose the status of each species during breeding and nonbreeding seasons in New Jersey from among 7 categories provided:

1. Endangered: a species whose prospects for survival within the state are in immediate danger due to $\geq$1 factor, such as loss or degradation of habitat, overexploitation, predation, competition, disease, or environmental pollution. An endangered species likely requires immediate action to avoid extinction within the state.
2. Threatened: a species that may become endangered if conditions surrounding it begin to or continue to deteriorate. Thus, a threatened species is one that is already vulnerable as a result of small population size, restricted range, narrow habitat affinities, or significant population decline.
3. Special concern: a species that warrants special attention because of inherent vulnerability to environmental deterioration or habitat modification that would result in their becoming threatened. This category also would apply to species that meet the foregoing criteria and for which there is little understanding of their current status in the state.
4. Secure–stable: a species that appears to be secure in the state and not in danger of falling into any of the preceding 3 categories in the near future.
5. Unknown: a species that cannot be assigned to the preceding categories because not enough information exists on which to base a judgment.
6. No opinion: a species for which the participant does not possess sufficient information or experience on which to base a judgment.
7. Not applicable: a species that does not occur in New Jersey as a breeding species, during the nonbreeding season, or during migration in New Jersey.

For each status selected, we asked panelists to rate their level of confidence in their assessment by indicating a numeric designation from a scale of 1–8 (i.e., 1–2 = unreliable, 3–4 = risky, 5–6 = reliable, and 7–8 = certain). Unreliable meant a great risk of being wrong and of no use as a basis for a decision. Risky meant substantial risk of being wrong and unwilling to use as a basis for decision without other information. Reliable meant some risk of being wrong and willing to make a decision based on this. Certain meant low risk of being wrong.

In the explanation section for each species, we asked panelists to briefly state the basis for their status choice (i.e., underlying assumptions or facts to support their position) for all endangered, threatened, and special concern designations. Their explanations provided additional information for consideration by other panelists in subsequent rounds, as well as documentation of species status and threats for the state's administrative record. Participants could also use the explanation section to argue status designations made in preceding rounds.

Evaluations were returned to the principal investigator for

SPECIES STATUS ASSESSMENTS

GREAT BLUE HERON

BREEDING STATUS:
E T SC S U NO NA (circle one)

Confidence Level:
Unreliable Risky Reliable Certain
1 2 3 4 5 6 7 8 (circle #)

Explanation:

NON-BREEDING STATUS:
E T SC S U NO NA (circle one)

Confidence Level:
Unreliable Risky Reliable Certain
1 2 3 4 5 6 7 8 (circle #)

LITTLE BLUE HERON

BREEDING STATUS:
E T SC S U NO NA (circle one)

Confidence Level:
Unreliable Risky Reliable Certain
1 2 3 4 5 6 7 8 (circle #)

Explanation:

NON-BREEDING STATUS:
E T SC S U NO NA (circle one)

Confidence Level:
Unreliable Risky Reliable Certain
1 2 3 4 5 6 7 8 (circle #)

BLACK-CROWNED NIGHT HERON

BREEDING STATUS:
E T SC S U NO NA (circle one)

Confidence Level:
Unreliable Risky Reliable Certain
1 2 3 4 5 6 7 8 (circle #)

Explanation:

NON-BREEDING STATUS:
E T SC S U NO NA (circle one)

Confidence Level:
Unreliable Risky Reliable Certain
1 2 3 4 5 6 7 8 (circle #)

COOPER'S HAWK

BREEDING STATUS:
E T SC S U NO NA (circle one)

Confidence Level:
Unreliable Risky Reliable Certain
1 2 3 4 5 6 7 8 (circle #)

Explanation:

NON-BREEDING STATUS:
E T SC S U NO NA (circle one)

Confidence Level:
Unreliable Risky Reliable Certain
1 2 3 4 5 6 7 8 (circle #)

Figure 1. Example of the "first-round" species status evaluation form, sent to all panelists.

compilation. We created a new survey round that listed the number of panelists who chose each status designation for each species in each season (e.g., see boxed "Round 1" scores in Fig. 2), the median confidence level for each status designation, and the compiled panelists' explanations for each species (Fig. 2). Thus, we sent the second and subsequent rounds to participants for their continued evaluation, giving them the opportunity to consider the data, opinions, and explanations provided anonymously by others in each round. We compiled explanations separately by round, and added them iteratively to the evaluation sheets; information appeared one time in the explanation even if more than one panelist provided the same information; information provided in a previous round was not repeated in succeeding rounds. We included all explanations from panelists without judgment as to their accuracy. When 85% of participants agreed on a status, we dropped the species or season from subsequent rounds. Agreement among 85% of reviewers was determined a priori as indicating consensus (Dobkin 1994). In previous studies, consensus often was not defined, or implied to be 100%; Crance (1987) applied a minimum 80% agreement. We conducted 4 rounds. Following compilation of the fourth round, all participants received a summary of the final results.

ROUND 2: SPECIES STATUS ASSESSMENTS

See Instructions for Status and Confidence Level codes

GREAT BLUE HERON

BREEDING STATUS:

	E	T	SC	S	U	NO	NA (circle one)
Round 1		6	9	2			
Confidence		6.2	5.7	6.0			

NON-BREEDING STATUS:

	E	T	SC	S	U	NO	NA (circle one)
Round 1			2	9			
Confidence			5.5	6.0			

Confidence Level:

Unreliable		Risky		Reliable		Certain		
1	2	3	4	5	6	7	8	(circle #)

Confidence Level:

Unreliable		Risky		Reliable		Certain		
1	2	3	4	5	6	7	8	(circle #)

Explanation: Round 1: Seems to be holding on, with new colonies every year. Although increasing, numbers are still below the apparent historical numbers of the 1920's-1930's. Clearly increasing: the number of colonies has gone from 5 or 6 in the 1970's to over 20 in the 1990's. SC recom. because the birds are so concentrated and vulnerable to disturbance, toxics, disease, predators, wood cutting, etc. that the trend could reverse. Many colonies are quite small and could be subject to development. Still quite rare in northern NJ. Although they seem to be increasing, the loss of just 1 or 2 big colonies would severely decrease the total population. Too soon to remove from T&E list, especially since many colonies are closely allied with headwater areas that are rapidly developing. Original T status was based on small number of pairs with most concentrated at only 3 locations; over last 20 years data show a significant increase in both pairs and locations. There seems to be suitable habitat not used.

LITTLE BLUE HERON

BREEDING STATUS:

	E	T	SC	S	U	NO	NA (circle one)
Round 1		3	10			4	
Confidence		6.0	5.5				

NON-BREEDING STATUS:

	E	T	SC	S	U	NO	NA (circle one)

Confidence Level:

Unreliable		Risky		Reliable		Certain		
1	2	3	4	5	6	7	8	(circle #)

Confidence Level:

Unreliable		Risky		Reliable		Certain		
1	2	3	4	5	6	7	8	(circle #)

Explanation: Round 1: Seems stable in areas of reproduction, but problems of habitat, foxes and contaminants threaten. Current numbers not too different than 1977-78. LBHE is similar to YCNH - concentrated in rookeries they are vulnerable to foxes and other predators; some former rookery sites are abandoned. SC status as with GBHE, but may have a natural variability in population. T status because 7 birds/colony and 220 breeding adults translates to 31 colonies between Cape May and Pt. Pleasant - not a lot; if the mean colony size is highly variable, there are many fewer colonies and even fewer viable ones. Number of birds and colonies about the same as GBHE when that was listed as T.

Figure 2. Example of the "second-round" species status evaluation form, reflecting first-round status assessments and comments by panelists.

Nineteen of the original 21 panelists participated in the second assessment (1997–1998). We provided participants with summaries of new information from 2 sources that were not readily available to the public: the New Jersey Breeding Bird Atlas and surveys conducted by the New Jersey Endangered and Nongame Species Program. Evaluation forms used the same format as in the earlier assessment but were limited to the 13 species (and specific seasons) under consideration. Methodology also was the same except that the principal investigator was a designated Endangered and Nongame Species Program staff member (an assessment "coordinator"). We conducted 3 rounds during the second assessment.

Results

In the initial comprehensive assessment of 283 bird species for each of 2 seasons (566 assessments), consensus was reached in 4 rounds for 91% of the species and for 95% of the species/seasons classifications. Consensus was reached for 47 species in the first round, 132 of the 236 species considered in the second round, 59 of the 104 species considered in the third round, and for 18 of the remaining 45 species considered in the fourth round. Of the 21 panelists who had agreed to participate, the number who actually completed evaluation forms for each of the rounds was 19, 18, 17, and 19 in rounds 1 through 4, respectively.

Status designations could not be resolved for 27 species, of which only 3 species were unresolved in both breeding and nonbreeding seasons. Combined response and turnaround time (for compilation) was between 6 and 9 months for each round, with each successive round requiring less time than the preceding round.

Thirty (11%) of 283 species were categorized as either

Table 1. Final avian status designations for species classified as endangered or threatened in 2 assessments of species status in N.J., USA.

Species	Breeding status (confidence level)	Nonbreeding status (confidence level)
Pied-billed grebe (*Podilymbus podiceps*)	Endangered (6)	Special concern (5)
American bittern (*Botaurus lentiginosus*)	Endangered (6)	Special concern (5)
Black-crowned night-heron[a] (*Nycticorax nycticorax*)	Threatened (6)	Secure (6)
Yellow-crowned night-heron (*Nyctanassa violacea*)	Threatened (7)	Unresolved
Osprey (*Pandion haliaetus*)	Threatened (6)	Secure (5)
Bald eagle (*Haliaeetus leucocephalus*)	Endangered (7)	Threatened (6)
Northern harrier (*Circus cyaneus*)	Endangered (5.5)	Special concern (6)
Cooper's hawk[a] (*Accipiter cooperii*)	Threatened (6)	Secure (5)
Northern goshawk (*Accipiter gentilis*)	Endangered (6)	Secure (5)
Red-shouldered hawk (*Buteo lineatus*)	Endangered (6)	Threatened (6)
Peregrine falcon (*Falco peregrinus*)	Endangered (7)	Unresolved
Black rail (*Laterallus jamaicensis*)	Threatened (6)	Unresolved
Piping plover (*Charadrius melodus*)	Endangered (7)	Endangered (7)
Upland sandpiper (*Bartramia longicauda*)	Endangered (7)	Endangered (6)
Red knot[a] (*Calidris canutus*)	N/A	Threatened (6.5)
Roseate tern (*Sterna dougallii*)	Endangered (6.5)	Endangered (6)
Least tern (*Sterna antillarum*)	Endangered (7)	Endangered (6)
Black skimmer (*Rynchops niger*)	Endangered (6)	Threatened (5)
Barred owl (*Strix varia*)	Threatened (6.5)	Threatened (6)
Long-eared owl (*Asio otus*)	Threatened (6)	Threatened (5)
Short-eared owl (*Asio flammeus*)	Endangered (6)	Special concern (5)
Red-headed woodpecker (*Melanerpes erythrocephalus*)	Threatened (6)	Unresolved
Loggerhead shrike (*Lanius ludovicianus*)	Endangered (7)	Endangered (7)
Sedge wren (*Cistothorus platensis*)	Endangered (6)	Endangered (6)
Vesper sparrow (*Pooecetes gramineus*)	Endangered (6)	Threatened (5)
Savannah sparrow (*Passerculus sandwichensis*)	Threatened (6)	Secure (5.5)
Grasshopper sparrow (*Ammodramus savannarum*)	Threatened (6)	Special concern (5)
Henslow's sparrow (*Ammodramus henslowii*)	Endangered (6)	Endangered (6)
Bobolink (*Dolichonyx oryzivorus*)	Threatened (5)	Secure (6)

[a] Final status reached in second part (Birds II, 1997–1998) of the evaluation process.

endangered or threatened in the breeding or nonbreeding season. Nineteen of 283 species (7%) were designated as endangered, and 7 of these were categorized as endangered in both seasons. Fifteen species received threatened designations, but 4 of these were categorized as endangered in one season and threatened in the other. Thirty-six species received special concern designations, which included 5 species categorized as endangered or threatened in one season.

In the second assessment, consensus was reached in 3 rounds for 11 of the 13 species (85%). No consensus was reached for any of the 13 species in the first round, but was reached for 2 species in the second round and for 9 of the remaining 11 species in the third round. Response and turnaround time was 3–4 weeks for each round, and 16–19 reviewers participated in each round. The second assessment resulted in 6 changes to the initial status assessment, including the downgrade of 2 species from threatened to special concern. Two of the 13 species were classified as threatened from the initial assessment of special concern. Taken together, the 2 assessments resulted in final designations of 29 species as endangered or threatened, 13 of which were categorized as endangered or threatened in both seasons (Table 1).

We presented the results of the first bird status assessment, along with subsequent changes based on the second assessment, to the Endangered and Nongame Species Advisory Committee. The committee decided species designations that were unresolved in the Delphi process when the indecision was between priority designations. For example, participants were split in their assessment of Cooper's hawk (*Accipiter cooperii*; breeding season) between threatened and special concern, and the committee decided to designate the bird as threatened, a reclassification from its previous endangered status. The committee did not become involved in their own review of the biological basis used by the experts. They generally maintained a listed status (endangered or threatened) for species already on the endangered species list if the Delphi process indecision was between a listed and an unlisted status; thus, no species would be removed from the endangered species list unless there was consensus. If indecision was between listing a species for the first time versus special concern status, the committee examined the Delphi results for a majority of votes and the weight of the comments. We note that for the avian assessments, 2 of the panelists also served on the Endangered and Nongame Species Advisory Committee making the final decisions.

For all species lacking a consensus designation, the results of the Delphi process provided guidance for the agency by suggesting the species' status and related justification. Although we attempted to reach consensus on all species, we considered some species unresolved by the method when assessments resulted in approximate 50/50 splits between statuses. In all cases, the Endangered and Nongame Species Advisory Committee made the final determination of legal status changes. The committee's determinations followed the results of the Delphi process for all species in which an 85% consensus on status was

reached. For species with unresolved status, the committee used the Delphi process results to help make the judgment on status. For example, if a majority (but <85%) of panelists suggested a threatened status, the committee voted to assign the threatened status.

Discussion

Using this adaptation of the Delphi Technique, experts were able to state their opinion on each species' status and provide information to support it. Through the process of successive rounds, participants could modify their opinion based on information provided by all panelists. In this way, they could potentially learn new information and opinions and modify their own opinions where appropriate. Alternatively, if they believed strongly in their position, they could continue to assert that position and present additional data to support it.

The Delphi method is a combination of the best aspects of current methods, expert opinions, and attempts to quantify population trends and threats to species. Further, Dalkey (1969) showed that the anonymous controlled-feedback process made group estimates more accurate than the estimates resulting from face-to-face discussions. Applied in complex issues, it also has the advantage of allowing participants time to consider the questions (Hess and King 2002).

Species status designations carry regulatory implications and, therefore, are subject to tests in the legal system. Application of the Delphi Technique to species status determinations may make these designations more objective, ultimately making state endangered species law more defensible. The documentation created in the written discussion across rounds of reviews can be used in such legal challenges to support species status designations.

In recommending this method, we suggest limiting the number of species to be evaluated. Asking participants to make 566 assessments to cover all 283 bird species resulted in a process that took several years to complete, mainly due to slow response time. Most states are starting with existing lists of endangered species and conducting updates (Niles and Korth 2005). In these cases, it is possible to select species for which the status is likely to change or for which there are new data. Conducting the Delphi evaluation on only a subset of species for which there was concern substantially reduced the time to complete each round and was less taxing on all participants. These assessments typically were completed in less than 1 year. The first application of this method was developed and conducted by an outside expert under contract because staff time was limited and no staff members were familiar with the method. After establishment of the methodology, and particularly by limiting the evaluations to small subsets of species, it became reasonable for staff biologists to coordinate the assessments. Further, with the widespread availability of electronic mail, correspondence has become easier and faster, which can improve communication and lessen response time. Although this technique requires substantially more time than the single-meeting approach, we believe the benefits of the iterative process are worth the extra time and effort.

This method of species status assessment had the added benefit of helping New Jersey agency biologists to better understand the range of concerns as expressed by the experts involved, albeit anonymously. Experts often shared data otherwise unavailable, as well as anecdotal information useful to wildlife researchers and managers. Most importantly, agency biologists revised the state's endangered and threatened wildlife list with a high level of confidence in its accuracy and defensibility.

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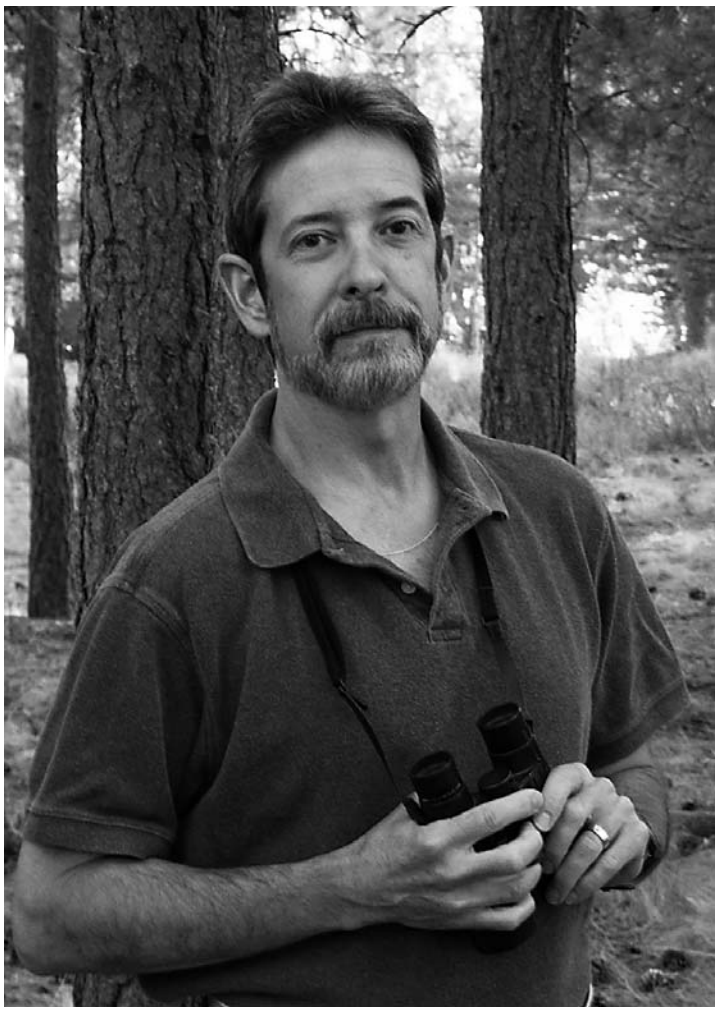

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